REMARKS

The Applicant has carefully reviewed the Office Action dated April 5, 2001. Claims 1 and 11 have been amended to more clearly describe the subject invention. Support for the amendments can be found on page 13, lines 17 - 18, page 14, lines 12 - 14, and elsewhere in the subject specification.

The rejection of Claims 1 - 8, and 10 - 19 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,826,453 to Prevey, III is respectfully traversed.

The Examiner takes the position that independent Claims 1 and 11 are anticipated by Prevey III. Referring to Claim 1, the method of inducing a layer of compressive stress in the surface of a part comprises the steps of selecting the region of the part to be treated, and selecting the magnitude of compression and the residual stress distribution to be induced at particular points along the surface of the selected region. The Applicant respectfully submits, that while the cited reference may disclose that the burnishing means is passed in a predetermined pattern **across the area** to be burnished and the **magnitude of compression** may be varied, it does not disclose that the magnitude of compression and the residual stress distribution will be selected for **particular points along the surface** of the selected region as required in Claim 1, as amended. Claim 1, as amended, also recites: "varying the pressure and the **rate** of pressure variation being exerted against the surface to produce the desired residual stress distribution and magnitude of compression within the surface." The Applicant respectfully submits that he is unable to find in the cited reference a disclosure of varying the pressure and the **rate of pressure variation** being exerted. The Applicant notes that the Examiner himself states that "Prevey III does not specifically disclose varying the pressure being exerted against the surface to produce a desired stress distribution and magnitude of compression along the surface." As taught in the subject application, by controlling the pattern of burnishing and by **gradually reducing** the magnitude of compression near the boundaries of the regions being burnished ("feathering"), the tensile zones which occur immediately adjacent and parallel to the boundaries may be reduced or eliminated. (See page 22, lines 17 through 20 of the subject specification). Accordingly, Claim 1, as amended, is not anticipated by the cited reference.

Referring to independent Claim 11, the amended Claim recites:

> "programming the control unit to increase, decrease or maintain the pressure being exerted against the surface at selected points along the selected pattern and to vary the rate of increase and decrease of pressure to obtain the desired residual stress distribution and magnitude of compression within the surface."

The Applicant respectfully submits that he is unable to find in the cited reference the method of **programming the control unit** to **increase, decrease or maintain** the pressure being exerted against the surface at **selected points** and which **varies the rate of** increase and decrease of the pressure to obtain the desired residual stress distribution and magnitude of compression. While the cited reference does disclose selecting a region to be burnished and applying the proper pressure or compressive force to be applied to the surface of the workpiece during the burnishing operation, **it does not disclose selecting points and varying the rate of increase or decrease of pressure.** As previously stated in reference to Claim 1, by varying the rate of increase or decrease of pressure, near the boundaries, the tensile zones which occur immediately adjacent and parallel to the boundaries may be reduced or eliminated. Accordingly, Claim 11, as amended, is not anticipated by the cited reference.

Referring to independent Claim 15 and dependent Claim 8, the Applicant respectfully submits that he is unable to find in the cited reference a method of "performing a second operation to induce a more shallow layer of compressive stress within the surface of the part to produce the desired stress distribution." Indeed, nowhere in the cited reference is there a disclosure of a **second operation** being performed to induce a more shallow layer of compressive stress within the surface of the part. As stated on page 15, lines 21 through 26 and page 16, lines 1 and 2:

> "The presence of lower compression at the surface has been found to allow the initiation of fatigue cracks at the surface of the part. Although these cracks are arrested as they propagate deeper into the more highly compressive material, the presence of surface cracks and the stress intensity factor associated with them is highly undesirable. It has been found that the method of this invention comprising thee steps of burnishing a part **in combination** with the secondary process identified herein above provides surface compression as well as deep compression resulting in a part having

> superior resistance to surface crack initiation and propagation." (Emphasis added).

Accordingly, Claim 15, which requires a second operation, is not anticipated by the cited reference.

The Examiner also takes the position, regarding Claim 8, "as shown in Figure 5a with respect to single point burnishing, a more shallow layer of compressive stress is induced within the surface (at a depth of 1.0 mm) of the part than near the surface (at a depth of 0.25 mm) of the part." The Applicant respectfully submits that Figure 5a of the cited reference shows that the residual compressive stress induced by the method taught varies with respect to depth, whereas the method taught and claimed in the subject application includes the step of inducing a second layer, distinct from the layer formed by the first operation, of residual compressive stress along the surface of the part. Accordingly, Claim 8 is not anticipated by the cited reference.

Referring to independent Claim 16, the Examiner takes the position that "Prevey, III discloses an apparatus (100) for inducing compressive stress in the surface of a part comprising: a burnishing member (114); a socket (108) having an inner chamber (134) and a seat (110) for receiving the burnishing member; means for applying force against the burnishing member for exerting pressure against the surface of a part (138); means for providing constant volume to the fluid to the inner chamber (an external fluid supply); wherein the socket provides clearance between the seat and the burnishing member for permitting fluid to pass."

The Applicant respectfully submits that the burnishing apparatus described in the cited reference **does not** provide a "constant volume of fluid to said inner chamber" as required in Claim 16. Indeed, during the burnishing process, the burnishing apparatus of the cited reference will provide a **variable amount** of fluid to the inner chamber. The Examiner has taken the position, that "It is inherent that some means is provided for monitoring and adjusting the fluid pressure from the external surface, such that the compressive force can be precisely regulated." However, as stated in column 6, lines 40 - 56 of the cited reference:

> "The proper pressure or compressive force to be applied to the surface 178 of the workpiece 144 during burnishing operation is provided by carefully tightening or loosening the adjustment screw 162. Because the burnishing

> ball 114 is coupled to the adjustment screw 162 through the spring means 166, tightening or loosening the adjustment screw 162 will cause the spring means 166 to compress or expand axially and will correspond to a given force exerted on the surface 178 of the workpiece 144 by the burnishing ball 114. **Further, because the burnishing ball 114 is coupled through a spring means 166 having a known spring characteristic, slight variations in the workpiece surface 178 will be absorbed by the spring means 166 without affecting the burnishing operation.**" (Emphasis added).

Thus, while the compressive force can be precisely set, the apparatus of the cited reference, unlike the apparatus of the subject application, **will not adjust to slight variations in the workpiece surface.**

In contrast, Claim 16 recites "Means for providing a **constant volume of fluid** to said inner chamber." As stated on page 17, lines 2 - 5:

> "The socket 102 is further provided with a fluid passage 118 in flow communication with the seat 112 and extends from the seat 112 through the inner chamber 114 to a fitting (not shown) for connecting to a **positive displacement pump** 120 for providing a **constant volumetric flow of fluid** from a fluid supply 122 to the seat 112...the positive displacement pump 120 is preferably coupled to a direct current (DC) electric motor 126 and a fast acting motor speed control 128. The motor speed control 128 functions to maintain a constant angular velocity of the motor 126 to **sustain** the constant volumetric fluid flow to the socket 102 **regardless of any changes in pressure**." (Emphasis added)

As stated on page 18, lines 12 - 20 of the subject application:

> "It should now be apparent to those skilled in the art that the constant flow burnishing apparatus 100 of the present invention, unlike conventional constant pressure burnishing apparatus that follow the surface topography of the part, automatically increases the force F being applied to the burnishing member 106, and the corresponding pressure being exerted against the surface 108, on high points and decreases on low points along the surface 108. Accordingly, the pressure or the compressive force exerted on the

surface 108 of the part 110 by the burnishing member 106 can be **precisely** regulated to provide **optimum surface finish and uniform burnishing of the part**." (Emphasis added).

Thus, unlike the burnishing apparatus described in the cited reference whereby slight variations in the workpiece surface will be **absorbed by the spring means** without affecting the burnishing operation, the constant volume apparatus of the subject application can be used so that slight variations in the surface of the workpiece **will not be absorbed** and permits the compressive force to be precisely regulated. In this way, Claim 16 is not anticipated by the cited reference.

The Applicant respectfully submits that for a reference to anticipate the subject invention, **each and every element or step** of the rejected claim must be taught (i.e. identically described) in the cited reference. The mere fact that a reference's generically disclosed structure or method of operation might fortuitously have been built or used in accordance with the narrower limitations of the subject claims cannot constitute anticipation. Accordingly, Claims 1 - 8, and 10 - 19 are not anticipated by the cited reference.

In view of the foregoing, the rejection of Claims 1 - 8, and 10 - 19 under 35 U.S.C. 102(b) as being anticipated by U.S. patent 5,826,453 to Prevey III should be withdrawn.

The rejection of Claim 9 under 35 U.S.C. 103(a) as being unpatentable over U.S. patent No. 5,826,453 to Prevey III is respectfully traversed.

The Examiner takes the position that Prevey III discloses the invention of independent Claim 1, but does not disclose the additional step of removing a layer of material along the surface being in low compression or tension as required in dependent Claim 9. The Examiner, however, takes Official Notice that polishing or buffing a workpiece removes a layer of material along the surface of a material. The Examiner also states that it is also known that polishing and buffing can refine the surface of a workpiece and reduce surface stress levels. Accordingly, the Examiner takes the position that it would have been obvious to one of ordinary skill in the art, at the time of the invention, to have polished the workpiece of Prevey III, in order to remove a layer of material along

the surface, in order to reduce surface stress levels in a workpiece.

Claim 1, as amended, recites the steps of:

> "selecting the magnitude of compression and the residual stress distribution to be induced at particular points along the surface of the selected region;
>
> exerting pressure against the surface of the selected region, the pressure being applied in a selected pattern along the surface to form zones of deformation having a deep layer of compressive stress; and
>
> varying the pressure and the rate of pressure variation being exerted against the surface to produce the desired residual stress distribution and magnitude of compression within the surface."

The Applicant respectfully restates the arguments made herein above with respect to independent Claim 1. While the cited reference discloses selecting a region to be burnished and applying the proper pressure or compressive force to be applied to the surface of the workpiece during the burnishing operation, **it does not disclose selecting points and varying the rate of increase or decrease of pressure.** As previously stated in reference to Claim 1, by varying the rate of increase or decrease of pressure, near the boundaries, the tensile zones which occur immediately adjacent and parallel to the boundaries may be reduced or eliminated. Further, while it may be know to one skilled in the art that polishing or buffing a workpiece removes a layer of material along the surface of a material and that such polishing and buffing can refine the surface of a workpiece and reduce surface stress levels, obviousness must be determined for the claimed subject matter as a whole, without ignoring the extraordinary improvement over the prior art or the different properties provided in the claimed subject matter. *The Applicant is unable to find any suggestion or teaching that would suggest the desirability of combining and modifying the methods taught in the cited references along the line of the subject invention.*

As stated, obviousness is based upon what the prior art taken as a whole would suggest to one of ordinary skill in the art. This is true even if all of the elements of a claim are disclosed in the various references. The mere fact that one may select and rearrange various elements disclosed in

the prior art to arrive at the claimed invention does not support a claim for obviousness unless there is some motivation to combine the references. Such a motivation cannot be found in the subject application, but must be shown by evidence that is clear and particular.

As previously stated, the Applicant is unable to find in the cited references any teaching of the method of inducing a layer of compressive residual stress in the surface of a part using the steps of independent Claim 1, as amended, and the step of removing a layer of material along the surface being in low compression or tension of dependent Claim 9 While it may be known that polishing and buffing can refine the surface of a workpiece and reduce stress levels, there is **no teaching** or suggestion that polishing and buffing **should or could** be used in conjunction with the process of inducing a compressive layer or residual stress within the surface of a part.

In addition to the forgoing, **secondary considerations** should also be evaluated in determining obviousness. Such is true even when the claimed invention involves only relatively simple mechanical concepts. It is a basic tenet of patent law that one is not permitted to ignore the results and advantages produced by claimed subject matter simply because the claim limitations may be similar to those of the prior art. Obviousness determinations must include consideration of the invention as a whole, including its structure, its properties, and the problem it solves. As stated on page 3, lines 20 through 23 of the subject application:

> "Until now, however, a method and apparatus have not been developed that permitted the residual stress distributions and the magnitude of compression to be controlled in such a manner as to optimize fatigue performance for a specific applied stress distribution."

Further, as stated on page 15, lines 25 and 26 and page 16, line 1 and 2:

> "It has been found that the method of this invention comprising the steps of burnishing a part in combination with the secondary process herein above provides surface compression as well as deep compression resulting in a part having superior resistance to surface crack initiation and propagation."

Accordingly, as shown in the above remarks, the method of inducing a layer of compressive residual stress in the surface of a part by the methods of independent Claim 1 and dependent Claim 9, is **significantly different** than the methods disclosed in the cited references and solves problems, not addressed in the cited reference, that is, optimizing fatigue performance for a specific applied stress distribution.

Accordingly, in view of the foregoing, the Applicant respectfully submits that the rejection of Claim 9 as being unpatentable over Prevey III should be withdrawn.

The rejection of Claims 1 - 8 and 10 - 19 under 35 U.S.C. 103(a) as being unpatentable over Prevey III, in view of JP 62-292,362 to Yonezama et al. is respectfully traversed.

The Examiner takes the position that Prevey III discloses the subject apparatus. However, Prevey III does not specifically disclose varying the pressure being exerted against the surface to produce a desired stress distribution and magnitude of compression along the surface. Yonezama et al. discloses a burnishing process whereby the pressure is gradually increased by means of a pressure controller, kept constant , and gradually lowered. Therefore, it would have been obvious to one of ordinary skill in the art to have varied the pressure being exerted against the surface to produce the desired stress distribution and magnitude of compression within the surface using the method of Prevey III, in light of the teachings of Yonezama et al., in order to burnish a part having different stress distribution requirements.

Yonezama et al. discloses a roll processing method for shaft fillet part with different stress distributions. The Applicant respectfully submits that it appears that Yonezama et al. shows only a fixed variation in phase with the position around the crank is implied (L1, L2 and L3 appear fixed at 15 degrees, 210 degrees, etc. around the crank). Further, the use of a "**sequencer**" indicates that the pressure pattern is also **fixed**. The Applicant submits that while Yonezama et al. may show the pressure being applied may increase and decrease during processing, he is unable to find and teaching or suggestion of selecting the magnitude of compression and the residual stress distribution to be induced at particular points along the surface of the selected region, applying pressure in a

selected pattern along the surface to form zones of deformation having a deep layer of compressive stress, and varying the pressure and the rate of pressure variation being exerted against the surface to produce the desired residual stress distribution and magnitude of compression within the surface. Indeed, Yonezawa et al. discloses rolling (applying pressure) **only** in a **circumferential direction.** In this way, pressure is **not** being applied in a **selected pattern** but in only one fixed direction. Thus, there is no teaching or suggestion that various patterns may or should be selected to arrive at a desired residual stress pattern.

With respect to Claim 11, the Applicant respectfully restates the arguments made above. The apparatus disclosed in Yonezawa et al. comprises a "**sequencer**." Accordingly, the Applicant submits that the use of the sequencer **does not permit programming** a control unit to pass a burnishing member of a burnishing apparatus over the selected region in the selected pattern or ro increase, decrease or maintain the pressure being exerted against the surface at selected points. Indeed, the pattern of increasing, maintaining and decreasing pressure is **fixed**. Further, said rolling is done in **only** the **circumferential direction**. In this way the cited references do not teach or describe the subject invention.

Referring to Claim 16, the Applicant respectfully restates the arguments made above. As previously stated, unlike the burnishing apparatus described in Prevey III whereby slight variations in the workpiece surface will be **absorbed by the spring means** without affecting the burnishing operation, the constant volume apparatus of the subject application can be used so that slight variations in the surface of the workpiece **will not be absorbed** and permits the compressive force to be precisely regulated. In this way, Claim 16 is not made obvious by the cited reference.

In view of the foregoing, Prevey III in view of Yonezawa et al. does not teach or even suggest varying the pressure being exerted against the surface to produce a desired stress distribution and magnitude of compression along the surface. While Yonezawa et al. does show that the pressure being exerted may be increase or decreased, it is done in a **fixed** pattern and does not teach or suggest **selecting** a magnitude or particular points along the surface of the selected region to produce an optimal residual stress pattern. Consequently, the Examiner has not met the burden of establishing the prima facie case of obviousness.

In view of the foregoing amendments and remarks, it is respectfully submitted that all of the Claims now pending are allowable over the art of record. Reconsideration of all claims now in this application is respectfully requested.

Respectfully submitted,

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MARKED UP COPY OF AMENDMENTS TO CLAIMS

1. (Amended) A method of inducing a layer of compressive residual stress in the surface of a part comprising the steps of:

selecting a region of the part to be treated;

selecting the magnitude of compression and the residual stress distribution to be induced at particular points along [in] the surface of the selected region;

exerting pressure against the surface of the selected region, the pressure being applied in a selected pattern along the surface to form zones of deformation having a deep layer of compressive stress; and

varying the pressure and the rate of pressure variation being exerted against the surface to produce the desired residual stress distribution and magnitude of compression within the surface.

11. (Amended) A method of inducing a layer of compressive stress in the surface of a part comprising the steps of:

selecting a region of the part to be treated;

selecting the magnitude of compression and the residual stress distribution to be induced in the surface of the selected region;

programming a control unit to pass a burnishing member of a burnishing apparatus over the selected region in the selected pattern to produce a zone of deformation having a deep layer of compression within the surface; and

programming the control unit to increase, decrease or maintain the pressure being exerted against the surface at selected points along the selected pattern and to vary the rate of increase and decrease of pressure to obtain the desired residual stress distribution and magnitude of compression within the surface.